



The role of emulsifier in stabilization of emulsions containing colloidal alumina particles

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ABSTRACT

This paper focuses on the study on rheological behaviour of emulsions, stabilized by both differently modified dispersible colloidal Boehmite alumina nanoparticles and a non-ionic emulsifier. Hysteresis loop measurements and dynamic rheological measurements were carried out in linear and non-linear regimes on two different emulsion systems – water-in-oil (W/O) and oil-in-water (O/W) emulsions.

Emulsion stabilized by a combination of moderately hydrophobic particles and a non-ionic emulsifier is an O/W emulsion. The addition of emulsifier improved the stability, however, did not show a significant influence on the emulsion flow behaviour. The emulsion, stabilized by both – nanoparticles and emulsifier – showed a complicated behaviour, i.e. sometimes it exhibited thixotropy or antithixotropy and sometimes both of them.

Emulsion stabilized by rather hydrophobic particles and a non-polar emulsifier is a W/O emulsion. The emulsion is very homogenous and exhibited very weak thixotropy. Dynamic measurements showed that G' was almost equal to G'' and both parameters were frequency-dependent, indicating a viscous liquid-like system with little network structure if any. With addition of emulsifier, the rather elastic solid-like emulsion structure may be changed into the viscous liquid-like structure.

In order to get a better understanding of relationships between rheological behaviour and microstructure, differential scanning calorimetry (DSC) results and optical microscopic images of the emulsions studied were discussed.

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1. Introduction

Many soft materials of immense commercial importance, such as tooth pastes, concentrated emulsions and suspensions, colloidal gels, industrial slurries, pharmaceutical and cosmetic creams and a variety of soft food items, i.e., mayonnaise, demonstrate a time-dependent evolution of visco-elastic properties strongly affected by a deformation field [1]. This behaviour is termed as thixotropy [2,3] and is associated with build-up of a structure in these complex fluids under quiescent conditions and break-up of the structure under a deformation field. In antithixotropy, the descending curve rheograms are positioned above the ascending curve rheograms. According to Ghannam [4], when a shear stress is applied to an emulsion, the flow started, viscosity decreased, and the rate of aggregates dissociation increased while shear rate increased. On the other hand, because of the effect of the thermal agitation and

shear induced, the rate of the aggregates association is increased, which increases the emulsion viscosity. The antithixotropy indicates that shearing can promote temporary aggregation rather than breakdown due to the collision of the solid particles and droplets [3].

Particle-stabilized emulsions exhibit highly variable rheological behaviour useful in a wide range of technological applications. Currently, there is a lot of interest in using thixotropy to control spreading, film formation, coating of emulsions containing active ingredients [5]. In our previous study [6], rheological behaviour of two different water–oil emulsion systems stabilized solely by modified colloidal alumina at different storage time was investigated. Pickering emulsions stabilized by moderately hydrophobic particles (oil-in-water emulsion) exhibited an inhomogeneous structure, relative large yield stresses and thixotropic flow behaviour, indicating a formation of a three-dimensional network. Emulsion stabilized by rather hydrophobic particles with a water contact angle around 90° (oil-in-water-in-oil multiple emulsion) was homogenous and showed thixotropy indicated the presence of a three-dimensional network. However, a phase

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